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The predictive power of the implied volatility of options traded OTC and on exchanges

Wayne W. Yu [a,*], Evans C.K. Lui [b], Jacqueline W. Wang [a]

[a] School of Accounting and Finance, The Hong Kong Polytechnic University, Hong Kong
[b] Department of Finance, The Chinese University of Hong Kong, Hong Kong

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ABSTRACT

This paper investigates the efficiency of stock index options traded over-the-counter (OTC) and on the exchanges in Hong Kong and Japan. Our findings suggest that implied volatility is superior to either historical volatility or a GARCH-type volatility forecast in predicting future volatility in both the OTC and exchange markets. This paper is also one of the first to compare the predictive power of the implied volatility of stock index options traded OTC to that of exchange-traded stock index options. Our evidence suggests that the OTC market is more efficient than the exchanges in Japan, but that the opposite is true in Hong Kong.

1. Introduction

The implied volatility of an option's price is widely believed to function as a forecast of the future volatility of the underlying asset over the remaining life of the option. Furthermore, if the option market is efficient, the implied volatility should subsume information contained in all other variables, including historical volatility, in explaining future volatility. Prior empirical studies provide mixed evidence on the information content of implied volatility relative to historically-based volatility. In general, early papers document that implied volatility is an inefficient predictor of future volatility. Day and Lewis (1992) examine S&P 100 index options with expiries from 1985 through 1989 and find that historical volatility contains predictive power about future volatility beyond that in implied volatility. Lamoureux and Lastrapes (1993) reach a similar conclusion using options on 10 stocks with expiries from 1982 through 1984. On the basis of a sample of S&P 100 index options from March 1983 through March 1987, Canina and Figlewski (1993) find that historical volatility, instead of implied volatility, is significantly correlated with future volatility, leading them to conclude that implied volatility has no information content.

But the findings in the papers above are subject to a few problems in their research designs. For example, implied volatility in Day and Lewis (1992) is computed from S&P 100 index options with remaining lives up to 36 trading days, which is related to one-week-ahead future volatility. Lamoureux and Lastrapes (1993) examine the one-day-ahead predictive power of implied volatility based on stock options with maturities up to 129 trading days. Both studies therefore suffer a maturity mismatch problem. In addition, both use overlapping samples, as do Canina and Figlewski (1993). These papers construct their data on a daily basis, resulting in an extreme degree of overlap in consecutive observations in the time series of historical and future volatility. Overcoming these problems, more recent papers find evidence that implied volatility embedded in option prices is informationally efficient in forecasting future volatility. Christensen and Prabhala (1998), using monthly non-overlapping data, re-examine the information content of implied volatility of S&P 100 index options. They find that implied volatility outperforms historical volatility in forecasting future volatility and even subsumes the information content of historical volatility in some of their models. They also document that the predictive power of implied volatility improved after the October 1987 stock market crash. Szakmary et al. (2003) find that for a large majority of the 35 futures options markets in the US, implied volatility outperforms historical volatility as a predictor of future volatility in the underlying futures prices over the remaining life of the option. Furthermore, historical volatility is subsumed

* Corresponding author. Tel.: +852 2766 7970; fax: +852 2330 9845.
E-mail address: afwyu@polyu.edu.hk (W.W. Yu).

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by implied volatility for most of the 35 markets examined. More recent studies on the implied volatility of S&P 500 index options show that it has the ability to predict the future return on the S&P 500 (Banerjee et al., 2007), and that it has the ability to anticipate the impact of non-continuous price changes (jumps) in the S&P 500 index (Becker et al., 2009).

In this paper, we investigate the efficiency of stock index options traded over-the-counter (OTC) and on the exchanges in Hong Kong and Japan. To our knowledge, our paper is among the first to examine the information content of the implied volatility of *stock index* options traded OTC.[1] Research using exchange-traded index options such as Day and Lewis (1992) and Christensen and Prabhala (1998) may suffer measurement errors that can affect the accuracy of the resultant implied volatility. These errors can arise from bid-ask spread, non-synchronous option and underlying asset prices, discrete strike prices, and time-varying maturity, as discussed in Canina and Figlewski (1993) and Christensen and Prabhala (1998).

There are four major differences between OTC and exchange-traded options. First, the quoted option price in the OTC market is actually implied volatility itself. Second, exchange-traded stock index options have a fixed number of expiration months at any given point in time, resulting in varying time-to-expiration. In contrast, the OTC stock index options have constant maturity. For example, on any given day, a 1-month OTC option will expire in exactly one month. Third, OTC options are always at-the-money, thereby reducing variations in implied volatility owing to the volatility "smile" in which implied volatility varies with the strike price. Discrete strike prices for exchange-traded options mean that even the nearest-the-money options are only approximately at-the-money, subjecting the computed implied volatility to the volatility smile effect. Finally, the OTC market is generally more liquid since most option exchanges, including those in Hong Kong and Japan, impose position limits for each investor. Consequently, professional (institutional) investors prefer to trade options in the OTC market because of its deeper liquidity and anonymity. Although official data on the OTC option markets do not exist, our discussion with many option traders reveals that the turnover of OTC index options is much higher than the corresponding exchange-traded index options in Hong Kong and Japan.

Another consideration, as we will discuss in more detail in Section 2, is that the implied volatility of exchange-traded options in our study is more carefully derived by our data provider, Bloomberg. First, Bloomberg makes an adjustment in ascertaining each option's settlement price on each day to minimize measurement problems resulting from the bid-ask spread and non-synchronous closing prices between the spot and options markets. In addition, our implied volatility is also less subject to the volatility smile effect owing to a weighting scheme employed by Bloomberg. In particular, at the end of each trading day, Bloomberg uses three options of the same class (three calls or three puts) closest to at-the-money to compute the implied volatility of the call or put options. For the three options of each class, Bloomberg's weighting scheme gives much more weight to at-the-money options than to either out-of-the-money or in-the-money options.

Perhaps the most noteworthy feature of our study is that it is one of the first to test the efficiency of the OTC market in relation to the exchanges. As mentioned earlier, professional (institutional) investors are more likely to execute their option trading strategies in the OTC market because of its deeper liquidity and anonymity, while retail (individual) investors are the major participants in the option exchanges. To the extent that professional investors are more sophisticated in obtaining and processing information, the OTC implied volatility is expected to be a more efficient forecast of future volatility than is the implied volatility of exchange-traded options. But as noted above, Bloomberg takes great care in deriving exchange-traded implied volatility, a practice that may mitigate problems stemming from liquidity and other measurement errors. We therefore believe it is an empirical issue as to which market is more efficient.

Our paper is also motivated by the consideration that the options markets in Hong Kong and Japan are not as liquid as that in the United States.[2] The various measurement errors discussed above are exacerbated in less liquid markets. For example, Chang et al. (2009) report that, to deal with the low liquidity problem, the Hong Kong Stock Exchange (HKEx) applies a piecewise linear volatility function to determine the daily settlement prices. But they show that the adjustment procedure still results in significant overpricing for about 90% of HKEx traded option contracts. Furthermore, prior studies using non-US samples provide mixed evidence regarding the informational efficiency of the implied volatility in option prices. Doidge and Wei (1998) examine the Toronto Stock Exchange 35 index options market from January 1991 through July 1995 and find that implied volatility is outperformed by historical volatility. In fact, they report that implied volatility has the lowest predictive power about future volatility, compared with that using all other volatility forecasts, such as historical, GARCH (1,1), and EGARCH (1,1). Using a sample of FTSE 100 index options in the UK from June 1993 through May 1995, Gwilym and Buckle (1999) find that although implied volatility is informative of future volatility, historical volatility contains incremental information beyond that in implied volatility. But Hansen (2001) finds some evidence that the implied volatility of the Danish KFX stock index options is an efficient forecast of future volatility, after correcting the errors-in-variables problem in the sample. Although Fung (2007) does not focus on the superiority of implied volatility relative to historical volatility in forecasting realized volatility, he reports that the implied volatility of exchange-traded Hang Seng Index options outperformed a number of volatility predictors, such as trading volume and the open interest of both index options and index futures, at the time of the 1997 crash in Hong Kong.[3] Given the equivocal results in the non-US options markets, it is clear that further research on the information content of implied volatility is warranted, as both Hong Kong and Japan have gained importance as financial centers over the last few years.[4]

We summarize our findings as follows: First, for stock index options traded OTC in both Hong Kong and Japan, implied volatility subsumes historical volatility or a GARCH-type volatility forecast in predicting future volatility. We find similar results for stock in-

[1] OTC *currency* options have been used in a couple of earlier studies. Covrig and Low (2003) find that future volatility can be forecast by implied volatility in the OTC currency options market. Campa and Chang (1998) also use OTC currency options to examine whether the correlation derived from implied volatilities in the currency options can outperform alternative forecasts such as historical correlation.

[2] Using the ratio of the notional value underlying the stock index options traded in a year over the total market capitalization in a country as a measure of its option market's liquidity, we find that the stock index options market is the most liquid in the US with an average ratio of 0.7121, followed by Japan with an average of 0.4664, and Hong Kong with an average of 0.2413, for the years 2002–2006.

[3] Our paper further differs from Fung (2007) in two significant respects. First, we use the OTC option data and Bloomberg's exchange-traded options data in our tests of the informational efficiency of implied volatility. Second, our base sample begins from May 1998, after the 1997 market crash in Hong Kong. During an extremely volatile period such as a market crash, historical volatility, by design, is inferior to implied volatility in forecasting future realized volatility. Therefore, the information content of implied volatility is best examined in a non-crash period such as ours.

[4] According to the World Federation of Exchanges, in terms of the domestic market capitalization at the end of 2006, the New York Stock Exchange was the largest with a market cap of US $15,421 billion, the Tokyo Stock Exchange was the second largest with a market cap of US $4,614 billion, and the Hong Kong Stock Exchange was the sixth largest with a market cap of US $1,715 billion. More detailed information for the rankings can be found on the World Federation of Exchanges' Website: http://www.world-exchanges.org/publications/EQUITY106.XLS.